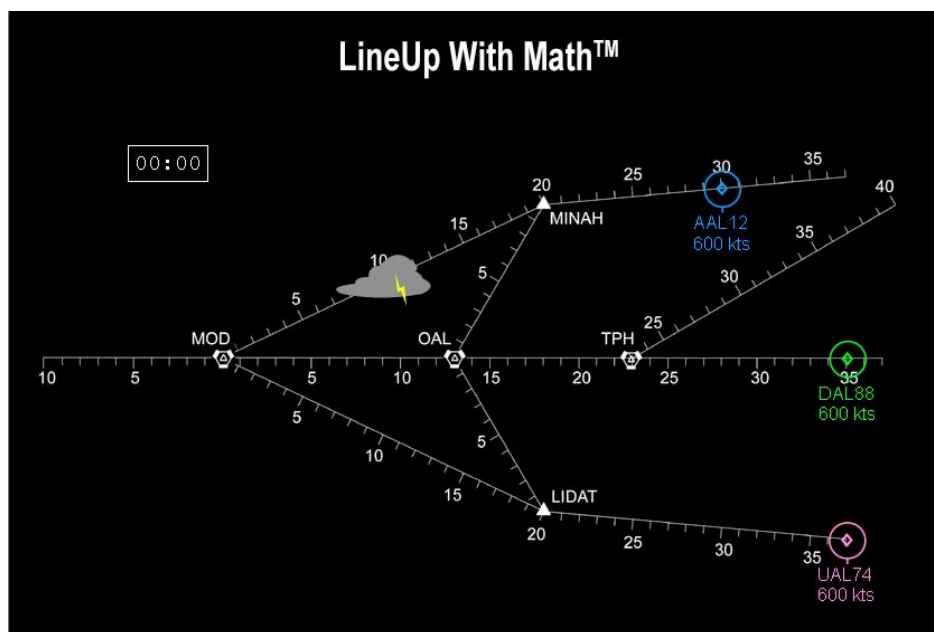




## An Educator Guide to

# *LineUp With Math™*

## Math-Based Decisions in Air Traffic Control Grades 5-9



Interactive Simulator



Workbook

**A Smart Skies™ Product**

[www.nasa.gov](http://www.nasa.gov)

<http://quest.nasa.gov/test/smartskies/lineup>

Educational Product	
Educators & Students	Grades 5-9

EG-XXXX-XX-XXX-ARC



Solve Distance-Rate-Time Problems



Develop Strategies



Recognize Patterns



Make Decisions



*Smart Skies™ LineUp With Math™* is available in electronic format through the NASA Education Portal—NASA’s electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address:

**<http://www.nasa.gov/audience/foreducators/topnav/materials/about/index.html>**

All *LineUp With Math™* curriculum materials are free and available to download from the *LineUp With Math™* teacher website:

**<http://quest.nasa.gov/test/smarts skies/lineup>**

Student access to the ATC Simulator is available at the following address:

**<http://quest.nasa.gov/projects/lineupsim>**

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EG-XXXX-XX-XXX-ARC



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# Educator Guide for *LINEUP WITH MATH*<sup>TM</sup>

## BECOMING ACQUAINTED WITH *LINEUP WITH MATH*<sup>TM</sup>

### A *Smart Skies*<sup>TM</sup> Educational Product

#### What is *LineUp With Math*<sup>TM</sup>?

*LineUp With Math*<sup>TM</sup> enables students to explore and apply decision-making and proportional reasoning skills to resolve distance-rate-time conflicts in realistic air traffic control problems. To solve the problems, students use a web-based interactive Air Traffic Control (ATC) Simulator that represents an air traffic controller's screen. The accompanying Workbooks provide the underlying mathematics and strategies to enable students to optimize their solutions.

*LineUp With Math*<sup>TM</sup> consists of six Problem Sets. Each typically contains:

- interactive ATC Simulator problems (web-based)
- a Student Workbook (print-based)
- supporting teacher materials

#### Access to Materials

All *LineUp With Math*<sup>TM</sup> materials, including the interactive ATC Simulator, are free and available on the *LineUp With Math*<sup>TM</sup> teacher website:

<http://quest.nasa.gov/test/smartskies/lineup/>

Student access to the ATC Simulator is available at the following address:

<http://quest.nasa.gov/projects/lineupsim>

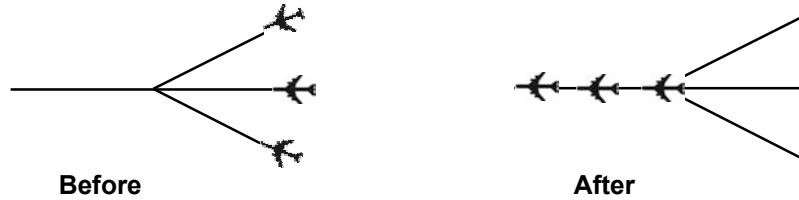
#### Background

*LineUp With Math*<sup>TM</sup> was developed under *Smart Skies*<sup>TM</sup>, a key part of the NASA Airspace Systems Program's educational efforts. *Smart Skies*<sup>TM</sup> supports the Program's goal to develop advanced computer-based systems to help pilots and air traffic controllers operate the nation's air transportation system with reduced flight delays and improved efficiency and access.

In the first *Smart Skies*<sup>TM</sup> product, *FlyBy Math*<sup>TM</sup>, students conduct experiments and use a variety of math methods to analyze and solve traditional distance-rate-time problems in air traffic control. As students identify conflicts in these 2-plane problems, they develop and apply proportional reasoning to predict distance-rate-time relationships.

## Overview

In *LineUp With Math<sup>TM</sup>*, the second *Smart Skies<sup>TM</sup>* product, students apply proportional reasoning to make decisions and resolve conflicts in realistic air traffic control problems involving two or more planes. The challenge in each problem is to “line up” the planes safely, with proper spacing, at a given intersection of jet routes.



*If you do not have easily available Internet access, you can use the Workbooks only.*

Students typically explore the problems using an interactive Air Traffic Control (ATC) Simulator. To increase and refine their decision-making skills, students use the print-based Student Workbooks that provide instruction and practice in mathematics and strategies to enable them to optimize their solutions. After completing the Student Workbooks, students return to the Simulator and apply their newly learned skills to “beat the clock” while lining up the planes with proper spacing.

*LineUp with Math<sup>TM</sup>* addresses the following types of ATC problems:

- two-plane and three-plane conflicts resolved with route changes
- two-plane and three-plane conflicts resolved with speed changes
- three-plane, four-plane, and five-plane conflicts resolved with speed changes or with speed and route changes.

*LineUp with Math<sup>TM</sup>* uses an airspace based upon a real sector in the National Airspace System. The sector, formally designated as ZOA33 and referred to as Sector 33, is located in northern California. In *LineUp with Math<sup>TM</sup>*, the sector distances have been modified to simplify student calculations.

## 6 Problem Sets

The *LineUp With Math<sup>TM</sup>* instructional materials have been packaged in the form of six Problem Sets. Each Problem Set contains:

- an interactive or multimedia component (e.g., Simulator, videos, classroom game)
- a Student Workbook
- a Teacher Guide with answers to Workbook and featured Simulator problems

Each of these components is described below.



## ATC Simulator

*If you do not have easily available Internet access, you may want to use the Classroom Game in place of the Simulator.*

The interactive ATC Simulator is a web-based computer program that teachers can access from the *LineUp With Math™* website or directly from a separate simulator website that gives students easy access to the ATC Simulator **only** (and not to the answers and solutions provided on the teacher website):

<http://quest.nasa.gov/projects/lineupsim>

The Simulator provides a user-friendly realistic simulation of Sector 33 as viewed by a controller on a sector display screen. At the beginning of each Simulator problem, two or more planes travel along merging jet routes. Students, working individually or in pairs, use proportional reasoning and distance-rate-time relationships to identify potential conflicts at the intersections of the jet routes. Depending upon the problem, students can resolve the conflict by changing plane routes or plane speeds.

As mentioned previously, the goal is to “line up” the planes safely, with proper spacing, at a given intersection. Students can rerun a problem to refine their solution and bring each plane to the intersection, not only safely, but also as quickly as possible. (The target time shown on the simulator screen for each problem is the optimal time for that problem.)

The Simulator features problems with 2, 3, 4, and 5 planes. The key two- and three-plane problems are supported by the Student Workbooks. The remaining two- and three-plane problems provide additional practice. The four- and five-plane problems enable students to explore more challenging scenarios.

The simulator website also includes the following user support materials:

- Animated tutorial
- 2-page quick reference guide
- technical requirements

## Other Interactive/Multimedia Components

**Videos:** *LineUp With Math™* includes two videos available for download on the *LineUp With Math™* website and on the Simulator website. The first video, “*What is LineUp With Math™?*”, introduces students to the overall goals and activities, and features scenes of students engaged in *LineUp With Math™*.

The second video, “*Welcome to Sector 33*”, presents the vocabulary, units, and graphical representations used in air traffic control. It prepares students for their first session with the interactive ATC Simulator. It also prepares students for the activities in the first Student Workbook (Problem Set 1).



**Classroom Game:** In Problem Sets 2 and 3, students resolve potential conflicts by changing the route of one or more planes. Problem Set 4 introduces students to the strategy of changing a plane's speed to avoid a conflict. To explore different approaches to speed reductions, *LineUp With Math*<sup>TM</sup> uses a classroom game.

In the game, students use masking tape or cashier's tape to lay out three merging jet routes. Then they act as "pilots" who step down the jet routes at a pace called out by a student "air traffic controller". The pilots must make speed change decisions to avoid conflicts at the intersection, while bringing the planes to the intersection as quickly as possible. After students experiment with the speed changes, they discuss their strategies. These discussions prepare students for the speed change problems they will encounter on the Simulator and in the Workbook in Problem Sets 5 and 6.

The Classroom Game, Experimenting with Speed Changes, is available to download from the *LineUp With Math*<sup>TM</sup> website.

## Student Workbooks

For each Problem Set, a print-based Student Workbook provides a structured learning environment for exploring two- or three-plane problems. Each Workbook contains paper-and-pencil worksheets that introduce students to pertinent air traffic control concepts as well as problem analysis and solution methods.

- Problem Set 1: the Workbook introduces students to the environment of real air traffic control.
- Problem Sets 2 and 3: the students use the Workbooks to analyze conflicts between two or three planes and to resolve the conflicts by rerouting.
- Problem Set 4: the Workbook addresses the basic effects of differences in speed.
- Problem Sets 5 and 6: the students use the Workbooks to analyze conflicts between two or three planes and to resolve the conflicts by changing plane speed.

Workbooks 2, 3, 5, and 6 include worksheets that feature ATC problems included on the Simulator. For these worksheets, the worksheet title includes the number of the associated Simulator problem.

Four- and five-plane problems are found on the Simulator only and are not supported by the Student Workbooks. These higher-level Simulator problems enable students to explore more challenging scenarios.

## Teacher Guides

Each of the six Problem Sets is accompanied by a Teacher Guide that includes:

- an overview
- a list of objectives, prerequisites, and materials
- a discussion and specification of the relevant ATC Simulator Problems (or other interactive/multimedia components)
- a discussion of key points for each Simulator problem and for each Workbook worksheet
- answer sheets for each Simulator problem and for each Workbook worksheet.





## Instructional Goals

*LineUp With Math<sup>TM</sup>* has two overarching goals:

- To enable students to use mathematical reasoning and problem-solving skills to investigate and solve realistic distance-rate-time problems in air traffic control.
- To offer students a variety of problem solving approaches, tools, skills, and experiences in the context of challenging, yet accessible, real-world problems.

The following table lists the materials and specific learning objectives for each *LineUp With Math<sup>TM</sup>* Problem Set.



## The LineUp With Math™ Problem Sets

Problem Set	Materials	Objectives
<b>1</b> Introduction to air traffic control sectors	<input type="checkbox"/> <i>Two Videos</i> --What is LineUp With Math? --Welcome to Sector 33 <input type="checkbox"/> <i>Student Workbook #1</i> <input type="checkbox"/> <i>Teacher Guide #1</i>	<ul style="list-style-type: none"> <li>• Learn the vocabulary of air traffic control.</li> <li>• Learn the units (nautical miles and knots) of air traffic control.</li> <li>• Learn to read and interpret an airspace sector diagram.</li> <li>• Learn the air traffic control spacing requirements for safety and efficiency.</li> </ul>
<b>2</b> 2-plane conflicts: change routes	<input type="checkbox"/> <i>Animated Tutorial</i> -- Introduction to the ATC Simulator <input type="checkbox"/> <i>Simulator Problems</i> 2-1*, 2-2*, 2-3*, 2-9, 2-10 <input type="checkbox"/> <i>Student Workbook #2</i> <input type="checkbox"/> <i>Teacher Guide #2</i>	<ul style="list-style-type: none"> <li>• Analyze a sector diagram to identify a spacing conflict between two planes, each traveling at the same speed.</li> <li>• Resolve the conflict by changing the route for one plane.</li> </ul>
<b>3</b> 3-plane conflicts: change routes	<input type="checkbox"/> <i>Simulator Problems</i> 3-1*, 3-2*, 3-7 <input type="checkbox"/> <i>Student Workbook #3</i> <input type="checkbox"/> <i>Teacher Guide #3</i>	<ul style="list-style-type: none"> <li>• Analyze a sector diagram to identify a spacing conflict among three planes, each traveling at the same speed.</li> <li>• Resolve the conflict by changing the route for one or more planes.</li> </ul>
<b>4</b> Effects of speed differences	<input type="checkbox"/> <i>Classroom Game</i> <input type="checkbox"/> <i>Student Workbook #4</i> <input type="checkbox"/> <i>Teacher Guide #4</i>	<ul style="list-style-type: none"> <li>• Learn that when a plane's speed is reduced, the difference in the plane's distance traveled can be calculated by multiplying the difference in speed by the amount of time traveled.</li> <li>• Learn how to associate a decrease in plane speed in knots with a decrease in distance traveled each minute.</li> <li>• Learn the correspondence between a 60-knot reduction in plane speed and the resulting decrease in distance traveled (in 1 minute) over a 10 Nmi interval on a jet route. (Students will encounter these particular speed reductions and multiples of 10 Nmi in subsequent Workbooks.)</li> </ul>
<b>5</b> 2-plane conflicts: change speeds	<input type="checkbox"/> <i>Simulator Problems</i> 2-4*, 2-5*, 2-6*, 2-7*, 2-8*, 2-11, 2-12, 2-13, 2-14, 2-15, 2-16 <input type="checkbox"/> <i>Student Workbook #5</i> <input type="checkbox"/> <i>Teacher Guide #5</i>	<ul style="list-style-type: none"> <li>• Analyze a sector diagram to identify a spacing conflict between two planes, each traveling at the same speed.</li> <li>• Resolve the conflict by changing the speed of one plane.</li> <li>• (Optional) Learn that a given percent reduction in plane speed yields the same percent reduction in distance traveled in the original amount of time.</li> </ul>
<b>6</b> 3-plane conflicts: change speeds	<input type="checkbox"/> <i>Simulator Problems</i> 3-3*, 3-4*, 3-5*, 3-6*, 3-8, 3-9, 3-10, 3-11, 3-12 <input type="checkbox"/> <i>Student Workbook #6</i> <input type="checkbox"/> <i>Teacher Guide #6</i>	<ul style="list-style-type: none"> <li>• Analyze a sector diagram to identify a spacing conflict among three planes, each traveling at the same speed.</li> <li>• Resolve conflicts by changing the speed of one or more planes.</li> <li>• Resolve conflicts by changing the speed or the speed and route of one or more planes.</li> </ul>
* The Simulator problems marked with an asterisk (*) are supported by worksheets in the print-based Student Workbooks.		



## Standards

*LineUp With Math™* supports the following national education standards for Mathematics and Science.

For each of the 50 states, the alignment of *LineUp With Math™* with the state mathematics standards is available on the *Smart Skies™* website.

## Mathematics Process Standards

*For a comprehensive alignment to the NCTM Standards and Expectations, see Appendix A of this document.*

Each *LineUp with Math™* Problem Set aligns with many of the National Council of Teachers of Mathematics (NCTM) Standards and Expectations for Grades 5-9.

*(Problem Solving K-12) Students “solve problems that arise in mathematics and other contexts.”*

*(Problem Solving K-12) Students “apply and adapt a variety of strategies to solve problems.”*

*(Communications K-12) Students “communicate their mathematical thinking coherently and clearly to peers, teachers, and others.”*

*(Connections K-12) Students “recognize and apply mathematics in contexts outside of mathematics.”*

*(Representation K-12) Students “select, apply, and translate among mathematical representations to solve problems.”*

*(Representation K-12) Students “use representations to model and interpret physical, social, and mathematical phenomena.”*

## Mathematics Content Standards

Each *LineUp With Math™* Problem Set also aligns with content standards and expectations from Algebra, Geometry, and Measurement as follows:

*(Numbers and Operations 6-8) Students “develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios.”*

*(Algebra 3-5) Students “identify and describe situations with constant or varying rates of change and compare them.”*

*(Algebra 6-8) Students “model and solve contextualized problems using various representations, such as graphs, tables, and equations.”*

*(Geometry 3-5) Students “describe location and movement using common language and geometric vocabulary.”*

*(Geometry 3-5) Students “create and describe mental images of objects, patterns, and paths.”*

*(Measurement 6-8) Students “solve simple problems involving rates and derived measurements for such attributes as velocity and density.”*



## Science Content Standards

Each *LineUp with Math*<sup>TM</sup> Problem Set aligns with several of the National Science Education Standards (NSES) for Grades 5-8 and 9-12.

In particular, the “Motions and Forces” Physical Science content standard is a key focus of each Problem Set:

*“As a result of their activities in grades 5-8 and 9-12, all students should develop an understanding of motions and forces.”*

The NSES cites this fundamental concept that underlies the standard:

*“(Grades 5-8) The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.”*

## Science Inquiry Standards

In addition to the Physical Science content standard, each *LineUp With Math*<sup>TM</sup> Problem Set aligns with Science as Inquiry Content Standard A:

*“As a result of activities in grades 5-8 and 9-12, all students should develop abilities necessary to do scientific inquiry.”*

In particular, each Problem Set provides opportunities for students to:

*“(Grades 5-8) Use appropriate tools and techniques to gather, analyze, and interpret data.”*

*“(Grades 5-8) Develop description, explanation, predictions, and models using evidence.”*

*“(Grades 5-8) Think critically and logically to make the relationships between evidence and explanations.”*

*“(Grades 9-12) Use technology and mathematics to improve investigations and communication*



## PREPARING TO TEACH *LINEUP WITH MATH*<sup>TM</sup>

To prepare to teach *LineUp with Math*<sup>TM</sup>:

### Select Materials

1. Go to the *LineUp With Math*<sup>TM</sup> teacher website:  
<http://quest.nasa.gov/test/smartskies/lineup>
2. On the website, view the video “What is *LineUp With Math*<sup>TM</sup>?”.
3. On the website, view the video “Welcome to Sector 33” to see an overview of the vocabulary, units, and graphical representations of air traffic control problems. This material is the backbone of both the simulator and the print-based workbooks.
4. On the website, view the video “Introduction to the ATC Simulator.”
5. Access and try the on-line Simulator. Online instructions are provided to assure that your computer is configured to support the Simulator.
6. Select the Problem Set you will use to introduce your students to *LineUp With Math*<sup>TM</sup>. We strongly recommend starting with Problem Set 1.
7. Follow the online instructions to select and download the materials for the Problem Set you have selected.

*If you do not want to print the documents, you can simply preview them online.*

### Review Materials

8. With the student and teacher materials in hand, and with access to the ATC Simulator, read the following Implementation section in this document.
9. Duplicate the Student Workbook to provide each student with one copy.
10. Now you're cleared for takeoff! ✈



## IMPLEMENTING *LINEUP WITH MATH*<sup>TM</sup> WITH YOUR STUDENTS

### Instructional Activities

The following sequence of instructional activities is recommended for implementing each *LineUp With Math*<sup>TM</sup> Problem Set. As you read this section, you may find it helpful to have a copy of a Student Workbook and the associated teacher materials.

*Estimated time:*  
30 minutes

1. If your students are new to *LineUp With Math*<sup>TM</sup>, begin with the two introductory videos:
  - “*What is LineUp With Math*<sup>TM</sup>?”
  - “*Welcome to Sector 33.*”

The video clips are available on the *LineUp With Math*<sup>TM</sup> teacher website.

*Estimated time:*  
30 minutes

2. If your students are new to *LineUp With Math*<sup>TM</sup>, introduce the ATC Simulator. You may want students to view the animated “*ATC Simulator User Tutorial.*” You may choose to project the Simulator and the animated tutorial for a whole class activity. Or you may choose to have the students work independently or in pairs on individual computers.

Students should access the Simulator and videos at the following address:

<http://quest.nasa.gov/projects/lineupsim>

*Estimated time:*  
30 minutes

3. For the Problem Set you have selected, assign the ATC Simulator problems featured in the Student Workbook. Provide time for your students to explore the Simulator and these assigned interactive ATC problems.

*Estimated time:*  
30-50 minutes

4. For the Problem Set you have selected, assign the worksheets in the accompanying Student Workbook.

*Estimated time:*  
30 minutes

5. After students have completed the Workbook, have them revisit the assigned problems on the Simulator to see if they can optimize their solution and “beat the clock.” (The target time shown on the simulator screen for each problem is the optimal time for that problem.) You may also wish to assign some of the supplementary Simulator problems. (See the table in the Instructional Goals section of this document or consult the Teacher Guide for the Problem Set.)

If you plan to teach a subsequent Problem Set, you may want to have your students experiment with the first few Simulator problems from that Set.

### Materials

#### Classroom Materials:

- Video clips
- ATC Simulator
- Student Workbook for selected Problem Set



**Teacher Materials:**

- *LineUp With Math<sup>TM</sup>* Educator Guide (this document)
- Teacher Guide for selected Problem Set with answers and solutions to all worksheets and to featured ATC Simulator problems
- Complete set of solutions to all ATC Simulator problems



## PROVIDING NASA WITH YOUR ASSESSMENT

In order to ensure that these educational materials are the best they can be for teachers and students across the nation, NASA needs your feedback and suggestions.

Please take a few minutes to fill out and mail the enclosed *Educator Reply Card* found in the back of this document, or respond online at the Internet address found on the card.

Thank you!





## APPENDICES

### Appendix A: Alignment to the National Education Mathematics Standards

Alignment of <i>LineUp with Math™</i> to the National Council of Teachers of Mathematics (NCTM) Standards and Expectations for Grades 3-5	
Mathematics Standard & Expectations	<i>LineUp With Math™</i> Activity
<b>Algebra</b>	
Use mathematical models to represent and understand quantitative relationships.	
Identify and describe situations with constant or varying rates of change and compare them.	--Identify and resolve distance, rate, time conflicts in air traffic control problems by varying plane speeds or changing plane routes.
<b>Geometry</b>	
Specify locations and describe spatial relationships using coordinate geometry and other representational systems.	
Describe location and movement using common language and geometric vocabulary	--Predict and plot the relative motion of two or more airplanes on given paths.
Use visualization, spatial reasoning, and geometric modeling to solve problems.	
Create and describe mental images of objects, patterns, and paths	-- Predict and plot the relative motion of two or more airplanes on given paths.
<b>Problem Solving</b>	
Solve problems that arise in mathematics and other contexts.	--Apply mathematics to solving distance, rate, and time problems for aircraft conflict scenarios.
Apply and adapt a variety of strategies to solve problems.	--Explore and apply a variety of strategies to optimize the solution of air traffic control conflicts.
<b>Communication</b>	
Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.	--Predict and resolve aircraft conflicts and explain results of mathematical calculations and simulations.
<b>Connections</b>	
Recognize and apply mathematics in contexts outside of mathematics.	--Apply mathematics to solving distance, rate, and time problems for aircraft conflict scenarios.
<b>Representation</b>	
Select, apply, and translate among mathematical representations to solve problems.	--Choose and apply a variety of strategies to optimize the solution of air traffic control conflicts.
Use representation to model and interpret physical, social, and mathematical phenomena.	--Use an interactive simulator plus calculation worksheets to model and resolve air traffic control conflicts.



**Alignment of *LineUp with Math™* to the National Council of Teachers of Mathematics (NCTM) Standards and Expectations for Grades 6-8**

<b>Mathematics Standard &amp; Expectations</b>	<b><i>LineUp With Math™</i> Activity</b>
<b>Numbers and Operations</b>	
Compute fluently and make reasonable estimates	
Develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios.	<p>--Use an interactive simulator plus calculation worksheets to apply proportional reasoning to identify and resolve distance, rate, time conflicts in air traffic control.</p> <p>--Use percent relationships to resolve distance, rate, time conflicts in air traffic control.</p>
<b>Algebra</b>	
Use mathematical models to represent and understand quantitative relationships.	
Model and solve contextualized problems using various representations, such as graphs, tables, and equations.	--Use an interactive simulator plus calculation worksheets to model and resolve air traffic control conflicts.
<b>Measurement</b>	
Apply appropriate techniques, tools, and formulas to determine measurements.	
Solve simple problems involving rates and derived measurements for such attributes as velocity and density.	--Identify and resolve distance, rate, time conflicts in air traffic control problems by varying plane speeds or changing plane routes.
<b>Problem Solving</b>	
Solve problems that arise in mathematics and other contexts.	--Apply mathematics to solving distance, rate, and time problems for aircraft conflict scenarios.
Apply and adapt a variety of strategies to solve problems.	--Explore and apply a variety of strategies to optimize the solution of air traffic control conflicts.
<b>Connections</b>	
Recognize and apply mathematics in contexts outside of mathematics.	--Apply mathematics to solving distance, rate, and time problems for aircraft conflict scenarios.
<b>Representation</b>	
Select, apply, and translate among mathematical representations to solve problems.	--Choose and apply a variety of strategies to optimize the solution of air traffic control conflicts.
Use representation to model and interpret physical, social, and mathematical phenomena.	--Use an interactive simulator plus calculation worksheets to model and resolve air traffic control conflicts.



Alignment of <i>LineUp With Math™</i> to the National Council of Teachers of Mathematics (NCTM) Standards and Expectations for Grades 9-12	
Mathematics Standard & Expectations	<i>LineUp With Math™</i> Activity
<b>Algebra</b>	
Analyze change in various contexts.	
Approximate and interpret rates of change from graphical and numerical data.	--Use an interactive simulator to identify distance, rate, time conflicts in air traffic control problems and resolve the conflicts by varying plane speeds.
<b>Problem Solving</b>	
Solve problems that arise in mathematics and other contexts.	--Apply mathematics to solving distance, rate, and time problems for aircraft conflict scenarios.
Apply and adapt a variety of strategies to solve problems.	--Explore and apply a variety of strategies to optimize the solution of air traffic control conflicts.
<b>Connections</b>	
Recognize and apply mathematics in contexts outside of mathematics.	--Apply mathematics to solving distance, rate, and time problems for aircraft conflict scenarios.
<b>Representation</b>	
Select, apply, and translate among mathematical representations to solve problems.	--Choose and apply a variety of strategies to optimize the solution of air traffic control conflicts.
Use representation to model and interpret physical, social, and mathematical phenomena.	--Use an interactive simulator plus calculation worksheets to model and resolve air traffic control conflicts.



## Appendix B: Glossary

<b>Aircraft</b>	Device(s) that are used or intended to be used for flight in the air, and when used in air traffic control terminology, may include the flight crew.
<b>Air Traffic</b>	Aircraft operating in the air or on an airport surface, exclusive of loading ramps and parking areas.
<b>Airspace</b>	The space lying above the earth or above a certain area of land or water, especially the space lying above a nation and coming under its jurisdiction.
<b>Air Traffic Control</b>	A service operated by appropriate authority to promote the safe, orderly and expeditious flow of air traffic.
<b>Call Sign</b>	The unique designator for each flight. Is composed of a 3-letter abbreviation for the airline name and a unique flight number.
<b>Conflict</b>	When 2 aircraft do not meet the minimum separation standards.
<b>Flight Plan</b>	Specified information relating to the intended flight of an aircraft that is filed orally or in writing with an FSS or an ATC facility.
<b>Flight Path</b>	A line, course, or track along which an aircraft is flying or intended to be flown.
<b>Ideal Spacing</b>	In air traffic control, the distance between aircraft to assure their orderly movement.
<b>Knot</b>	Speed for air and sea travel in nautical miles per hour.
<b>Minimum Separation</b>	In air traffic control, the minimum allowed distance between aircraft to achieve their safe movement in flight and while landing and taking off.
<b>Nautical Miles</b>	Unit of measure for distance in air and sea travel. A nautical mile is 1.15 times a statute mile used in land travel.
<b>Route</b>	A defined path, consisting of one or more courses in a horizontal plane, which aircraft traverse over the surface of the earth.
<b>Sector</b>	A geographic area of the airspace for which a controller is responsible.



## Appendix C: NASA Resources for Educators

### Smart Skies™ Website

The *Smart Skies*™ website contains links to additional educational materials related to Airspace Systems.

[http://quest.nasa.gov/projects/smart\\_skies](http://quest.nasa.gov/projects/smart_skies)

### NASA Education Home Page

**NASA's Education Home Page** serves as the education portal for information regarding educational programs and services offered by NASA for the American education community. This high-level directory of information provides specific details and points of contact for all of NASA's educational efforts, Field Center offices, and points of presence within each state. Visit this resource at the following address:

<http://education.nasa.gov>.

### NASA CORE

**NASA's Central Operation of Resources for Educators (CORE)** was established for the national and international distribution of NASA-produced educational materials in multimedia format. Educators can obtain a catalogue and an order form by one of the following methods:

NASA CORE  
Lorain County Joint Vocational School  
15181 Route 58 South  
Oberlin, OH 44074-9799

Toll Free Ordering Line: 1-866-776-CORE  
Toll Free FAX Line: 1-866-775-1460

E-mail [nasaco@leeca.org](mailto:nasaco@leeca.org)  
Home Page: <http://core.nasa.gov>

### Educator Resource Center Network

#### **Educator Resource Center Network (ERCN)**

To make additional information available to the education community, NASA has created the NASA Educator Resource Center (ERC) network. Educators may preview, copy, or receive NASA materials at these sites. Phone calls are welcome if you are unable to visit the ERC that serves your geographic area. A list of the centers and the regions they serve includes:

*AK, Northern CA, HI, ID, MT, NV,  
OR, UT, WA, WY*  
NASA Educator Resource Center  
**NASA Ames Research Center**  
Mail Stop 253-2  
Moffett Field, CA 94035-1000  
Phone: (650) 604-3574

*IL, IN, MI, MN, OH, WI*  
NASA Educator Resource Center  
**NASA Glenn Research Center**  
Mail Stop 8-1  
21000 Brookpark Road  
Cleveland, OH 44135  
Phone: (216) 433-2017



*CT, DE, DC, ME, MD, MA, NH, NJ,  
NY, PA, RI, VT*  
NASA Educator Resource Laboratory  
**NASA Goddard Space Flight Center**  
Mail Code 130.3  
Greenbelt, MD 20771-0001  
Phone: (301) 286-8570

*FL, GA, PR, VI*  
NASA Educator Resource Center  
**NASA Kennedy Space Center**  
Mail Code ERC  
Kennedy Space Center, FL 32899  
Phone: (321) 867-4090

*AL, AR, IA, LA, MO, TN*  
U.S. Space and Rocket Center  
NASA Educator Resource Center for  
**NASA Marshall Space Flight Center**  
One Tranquility Base  
Huntsville, AL 35807  
Phone: (256) 544-5812

*CA*  
NASA Educator Resource Center for  
**NASA Jet Propulsion Laboratory**  
Village at Indian Hill  
1460 East Holt Avenue, Suite 20  
Pomona, CA 91767  
Phone: (909) 397-4420

*VA and MD's Eastern Shores*  
NASA Educator Resource Center  
**GSFC/Wallops Flight Facility**  
Visitor Center Building J-17  
Wallops Island, VA 23337  
Phone: (757) 824-2298

*CO, KS, NE, NM, ND, OK, SD, TX*  
Space Center Houston  
NASA Educator Resource Center for  
**NASA Johnson Space Center**  
1601 NASA Road One  
Houston, TX 77058  
Phone: (281) 244-2129

*KY, NC, SC, VA, WV*  
Virginia Air & Space Center  
Educator Resource Center for  
**NASA Langley Research Center**  
600 Settlers Landing Road  
Hampton, VA 23669-4033  
Phone: (757) 727-0900 x 757

*MS*  
NASA Educator Resource Center  
**NASA Stennis Space Center**  
Building 1200  
Stennis Space Center, MS 39529-6000  
Phone: (228) 688-3338

*AZ and Southern CA*  
NASA Educator Resource Center for  
**NASA Dryden Flight Research Center**  
PO Box 273, M/S 4839  
Edwards, CA 93523-0273  
Phone: (661) 276-5009 or (800) 521-3416 x 5009

## Regional Educator Resource Centers

**Regional Educator Resource Centers** offer more educators access to NASA educational materials. NASA has formed partnerships with universities, museums, and other educational institutions to serve as regional ERCs in many states. A complete list of regional ERCs is available through CORE, or electronically via NASA Spacelink at <http://spacelink.nasa.gov/ercn>.



## NASA Television

**NASA Television (NTV)** features Space Station and Shuttle mission coverage, live special events, interactive educational live shows, electronic field trips, aviation and space news, and historical NASA footage. Programming has a 3-hour block—Video (News) File, NASA Gallery, and Education File— beginning at noon Eastern and repeated four more times throughout the day. Live feeds preempt regularly scheduled programming.

Check the Internet for programs listings at:

<http://www.nasa.gov/ntv>

For more information on NTV, contact:

NASA TV

NASA Headquarters - Code P-2

Washington, DC 20546-0001

Phone (202) 358-3572



## Appendix D: NASA Education Evaluation System Reply Card

Reply card goes here.